9.2 Interference propagation statistics

In the geostationary satellite case, the interference expressed as a pfd is assumed to be constant at the telemetry receiving site; i.e., line-of-sight conditions exist. This is not true for beyond line-of-sight propagation conditions; i.e., the received pfd will have a probability distribution that is a function of a number of parameters and is independent of the (G_1) and (G_2) distributions given in §§ 2.3 and 3.1. Thus, the interference pfd distribution function must be "convolved" with the resultant distribution functions of (G_1) and (G_2) to arrive at a (ΔG) as a function of $P(\Delta G)$. In this respect, the propagation model of Appendix 28 may be of use.

9.3 Coordination distances

The development of coordination distances similar to that of Appendix 28 may be possible. The propagation statistics as a function of distance and intervening terrain for the applicable propagation modes would need to be developed. The convolutions indicated in § 9.2 would then be performed to arrive at a (ΔG) as a function of distance. A 10m antenna pointed at the horizon on the azimuth would be assumed. All the necessary telemetry parameters are given in the preceding paragraphs. The interference criteria are given in § 5 for the terrestrial case. The other parameters are given in § 7.1, but I/N = 0.1538. From this, it would then be possible to compute a coordination distance as a function of the propagation modes and the EIRP density from the terrestrial sound broadcasting station.

9.4 Coordination considerations

The coordination considerations given in § 8.2 apply to the terrestrial interference case. The considerations given in §§ 8.5.3 and 8.5.4 for elevation angles near 0° also apply to this case.

10. Mobile aeronautical telemetry operation in the United States

Appendix 1 provides information on telemetry receiving stations in the United States.

[1] CCIR Report to WARC-92

FIGURE 1

Measured data on 2.44 metre diameter antennas

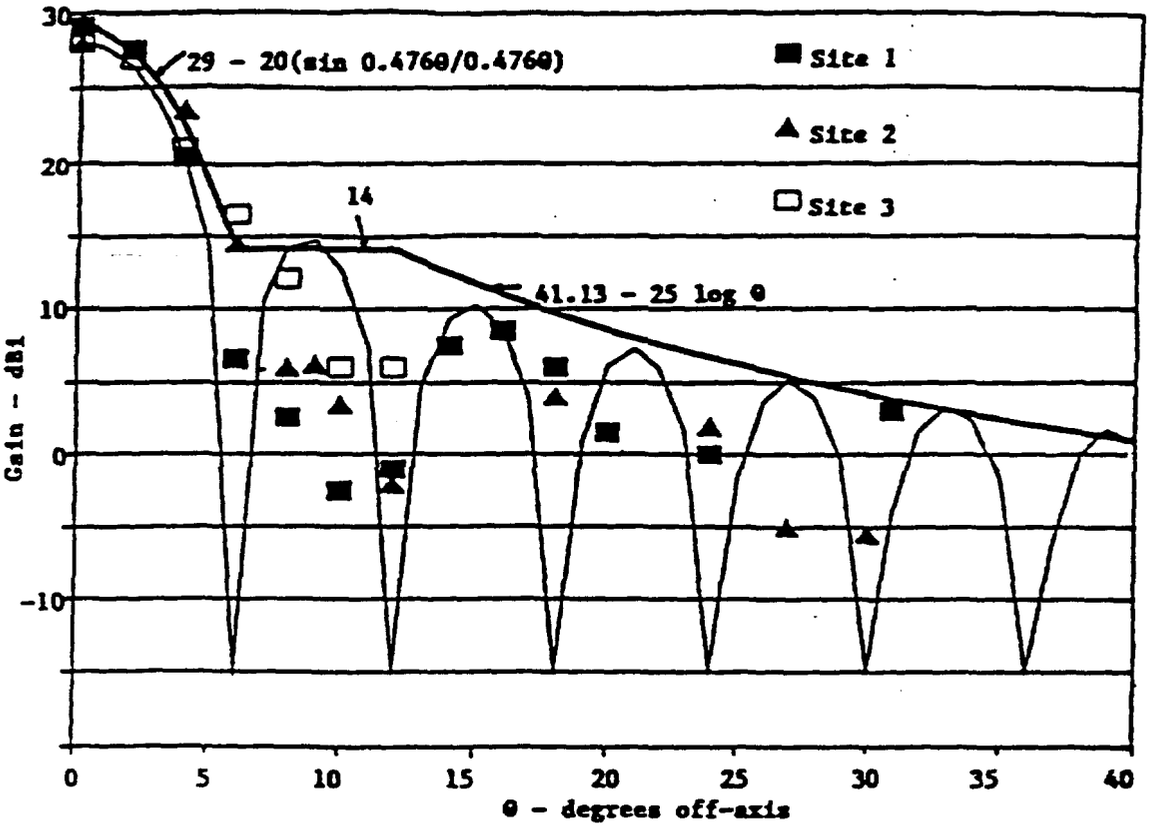


FIGURE 2

Telemetry receiving antenna off-axis gains

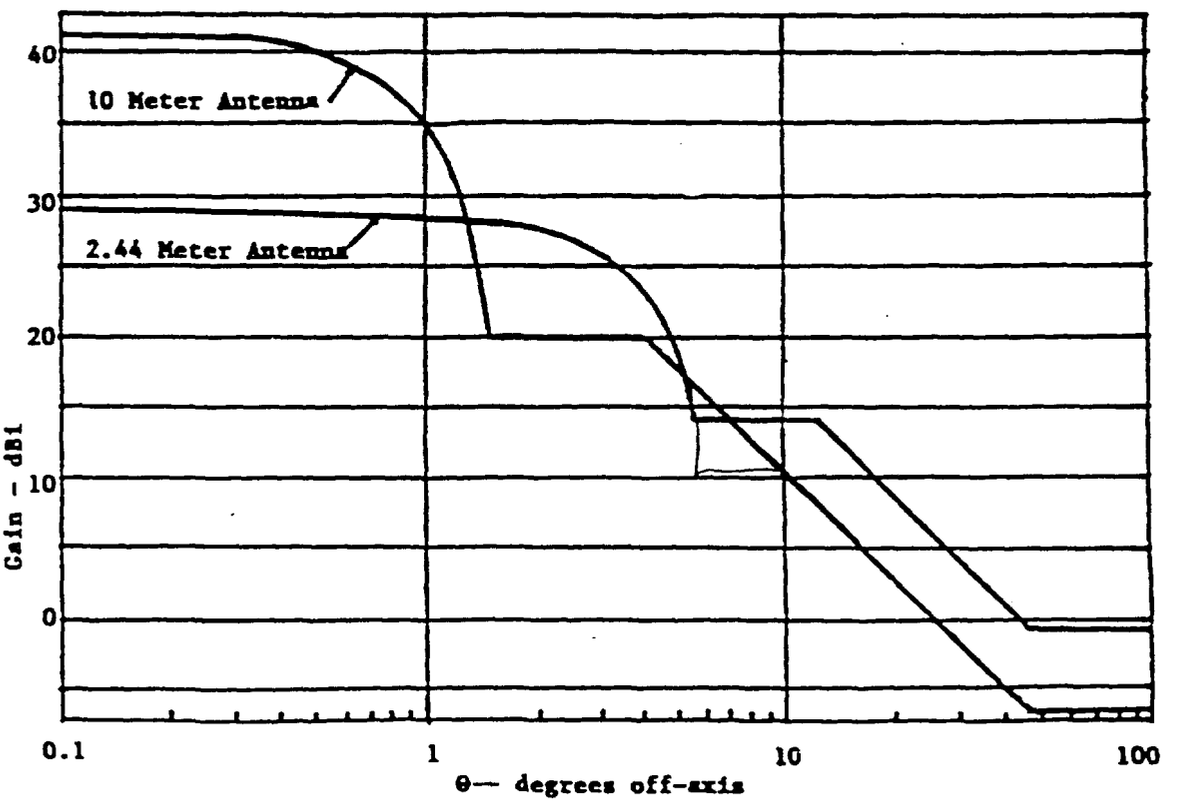


FIGURE 3

Airborne telemetry transmitting antenna gains (G_1)

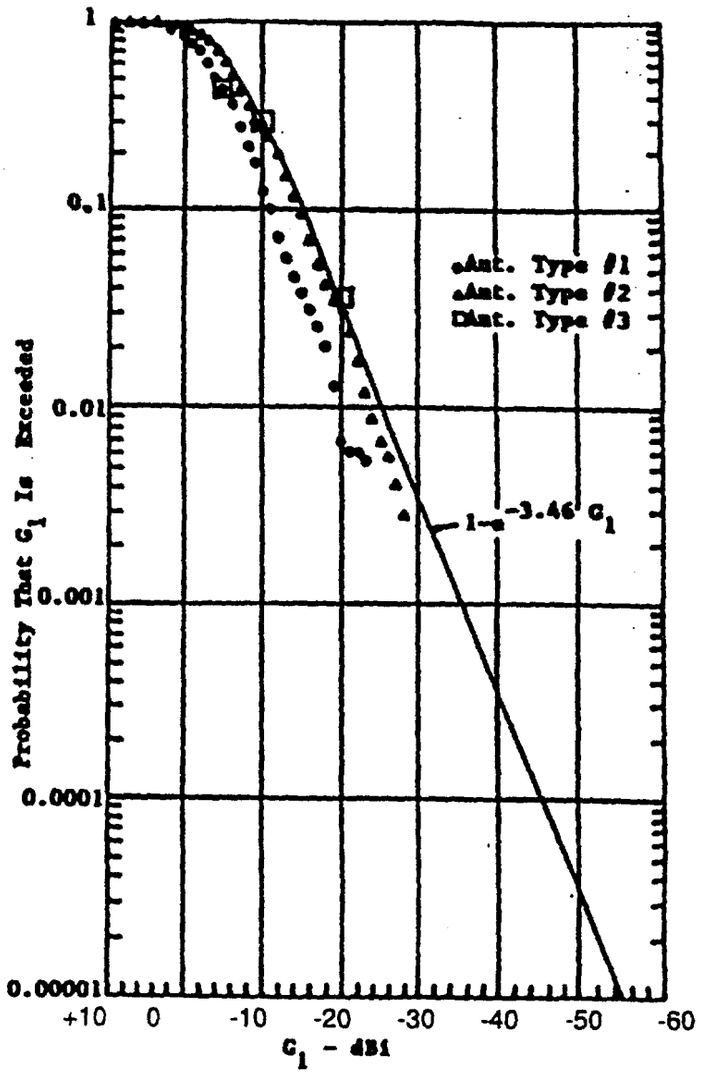


FIGURE 4

Non-geostationary model geometry

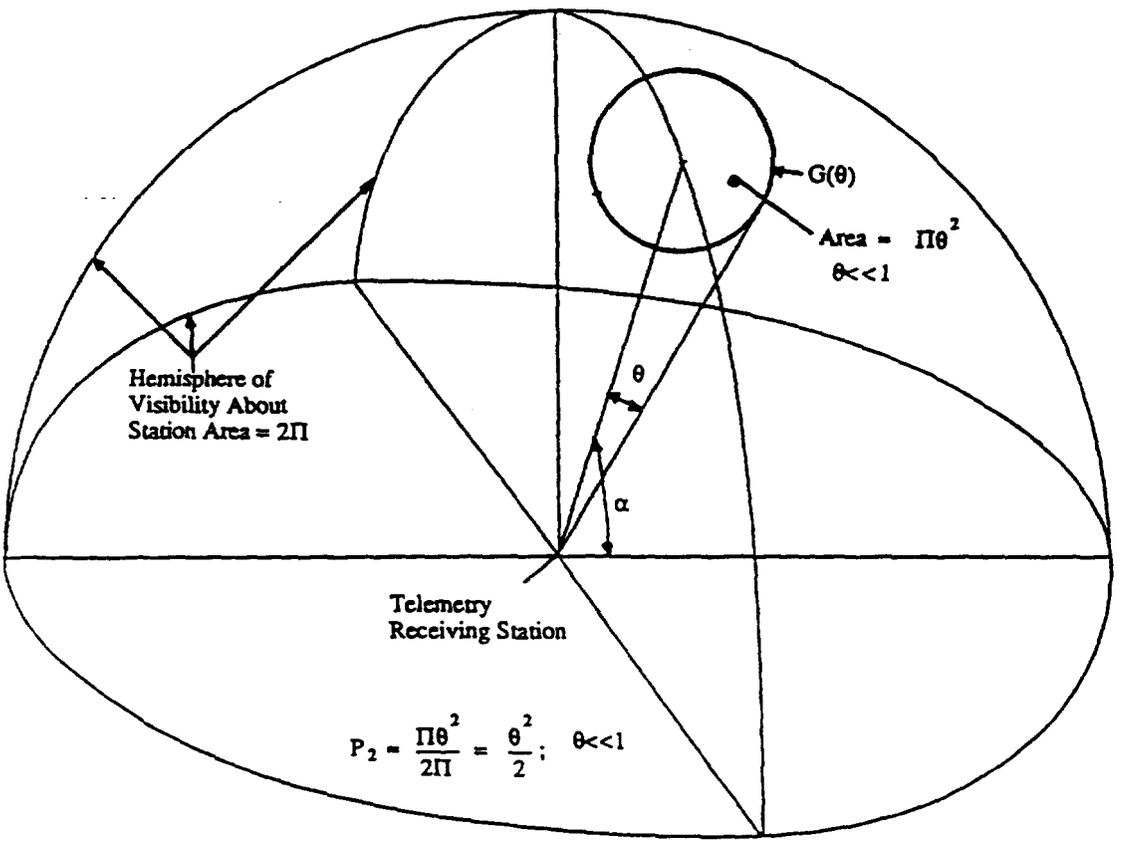


FIGURE 5

Telemetry receiving antenna gain probability (G_2)

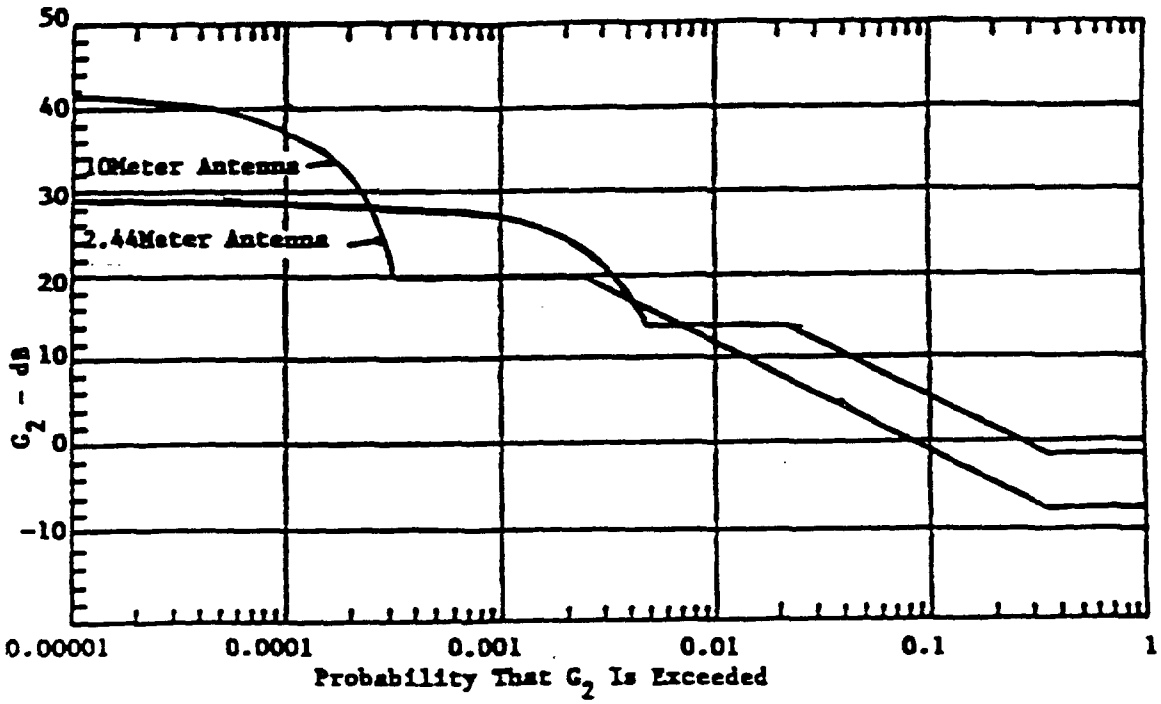


FIGURE 6

Decrease in usable range versus I/N

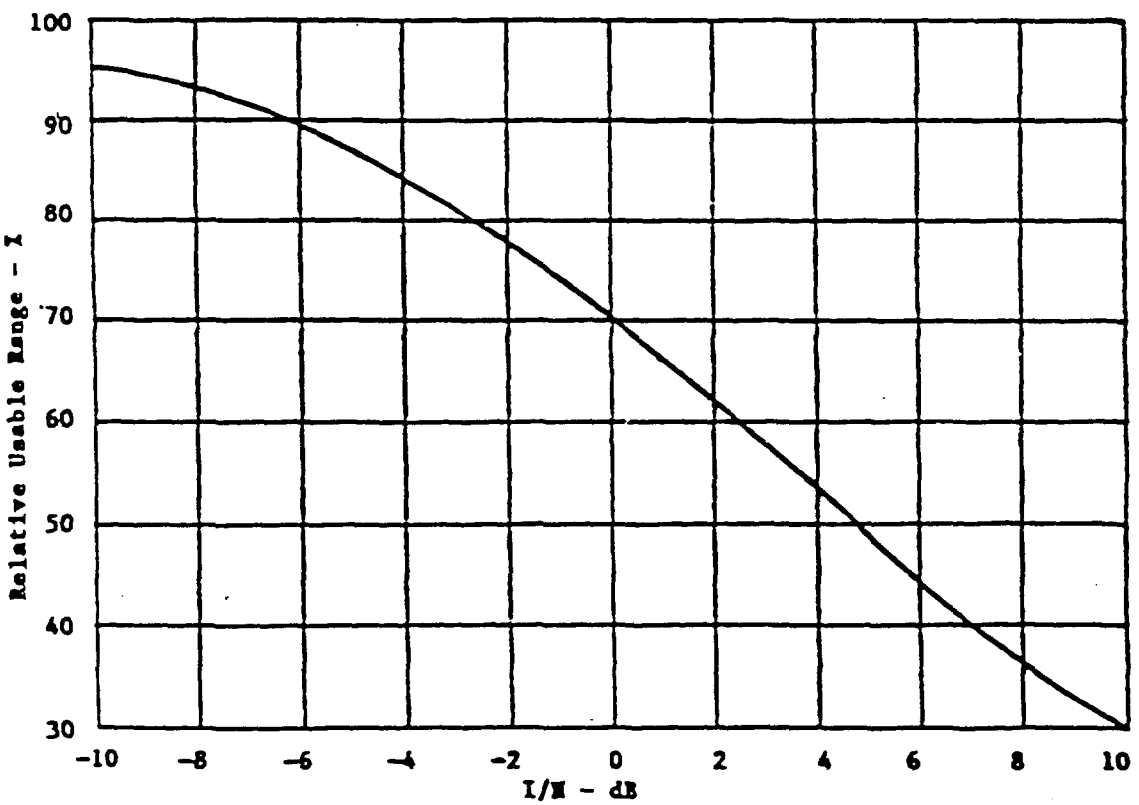


FIGURE 7

Geometry for "S" computations for geostationary satellites

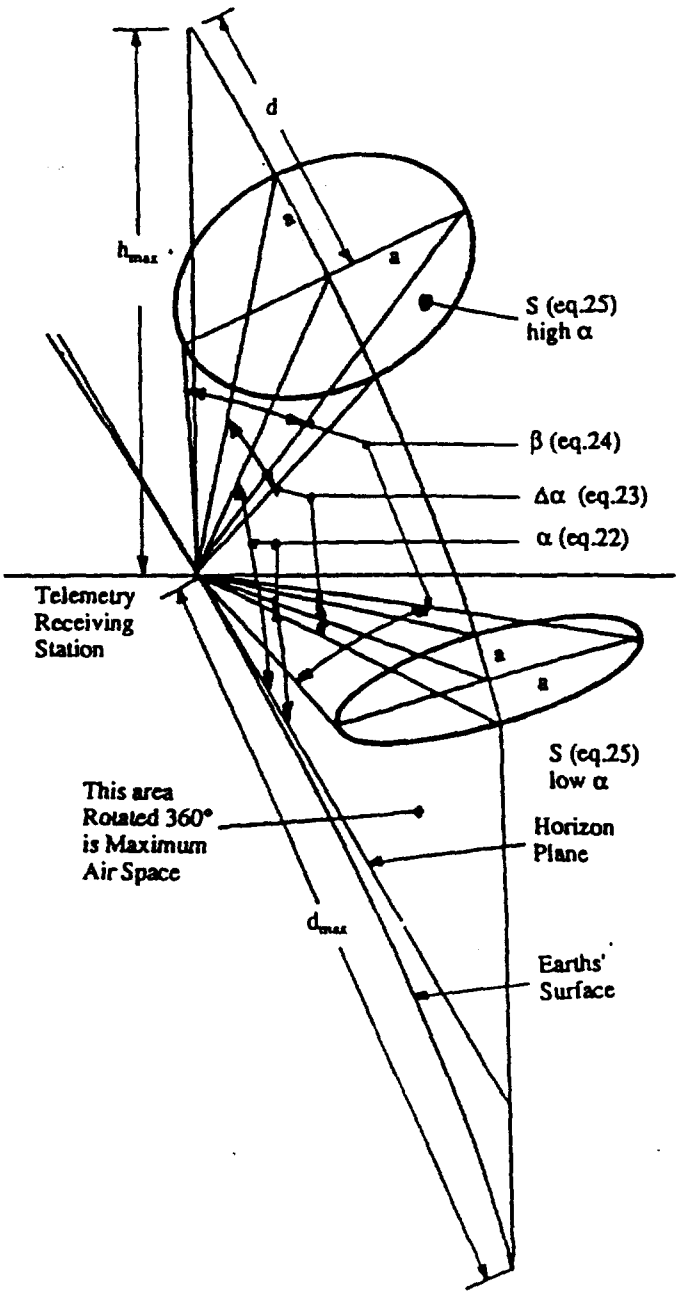


FIGURE 8

Escalation due to (S)

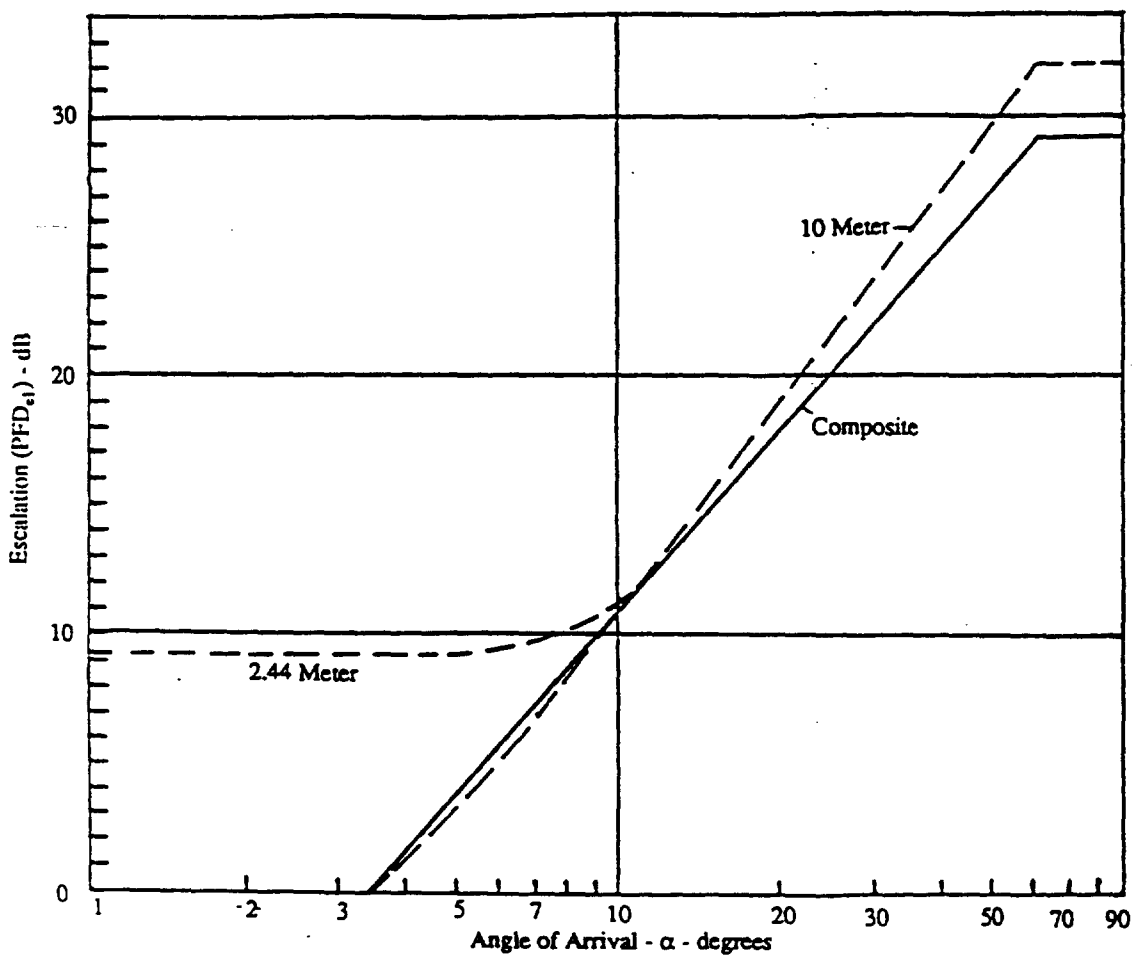


FIGURE 9

Geometry for excess margin escalation

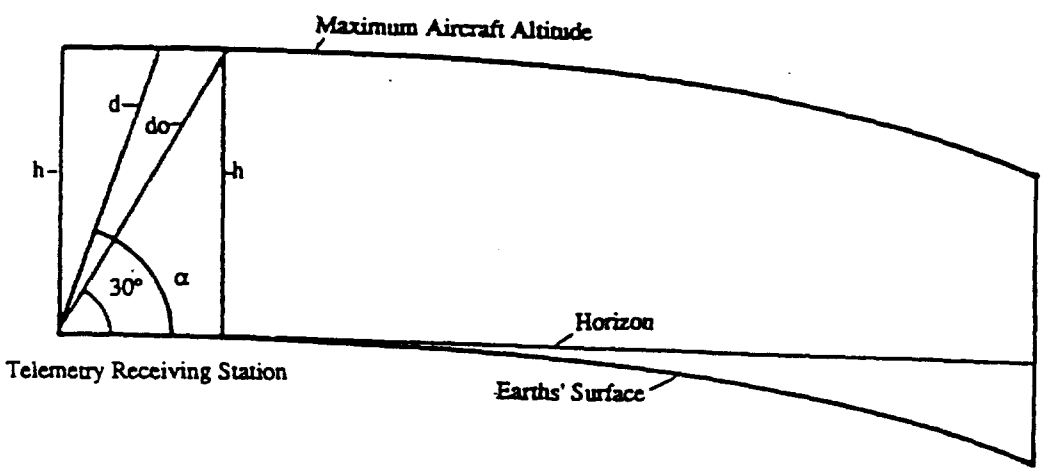


FIGURE 10

Aggregate and single entry thresholds for aeronautical telemetry receiving stations due to interference from geostationary satellites

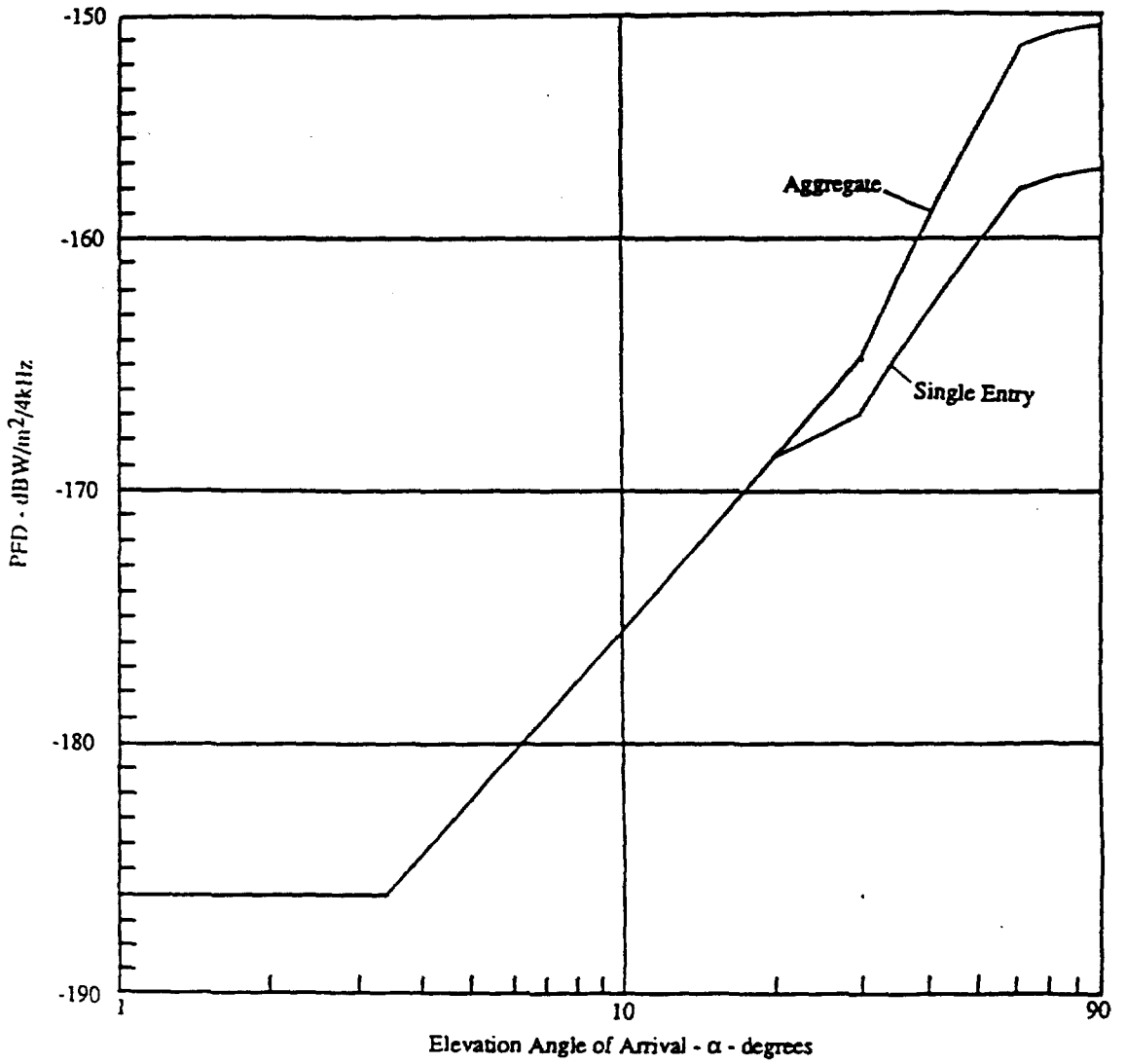


FIGURE 11

Allowable pfd versus on-axis gain of the telemetry antenna (Go) and (α)

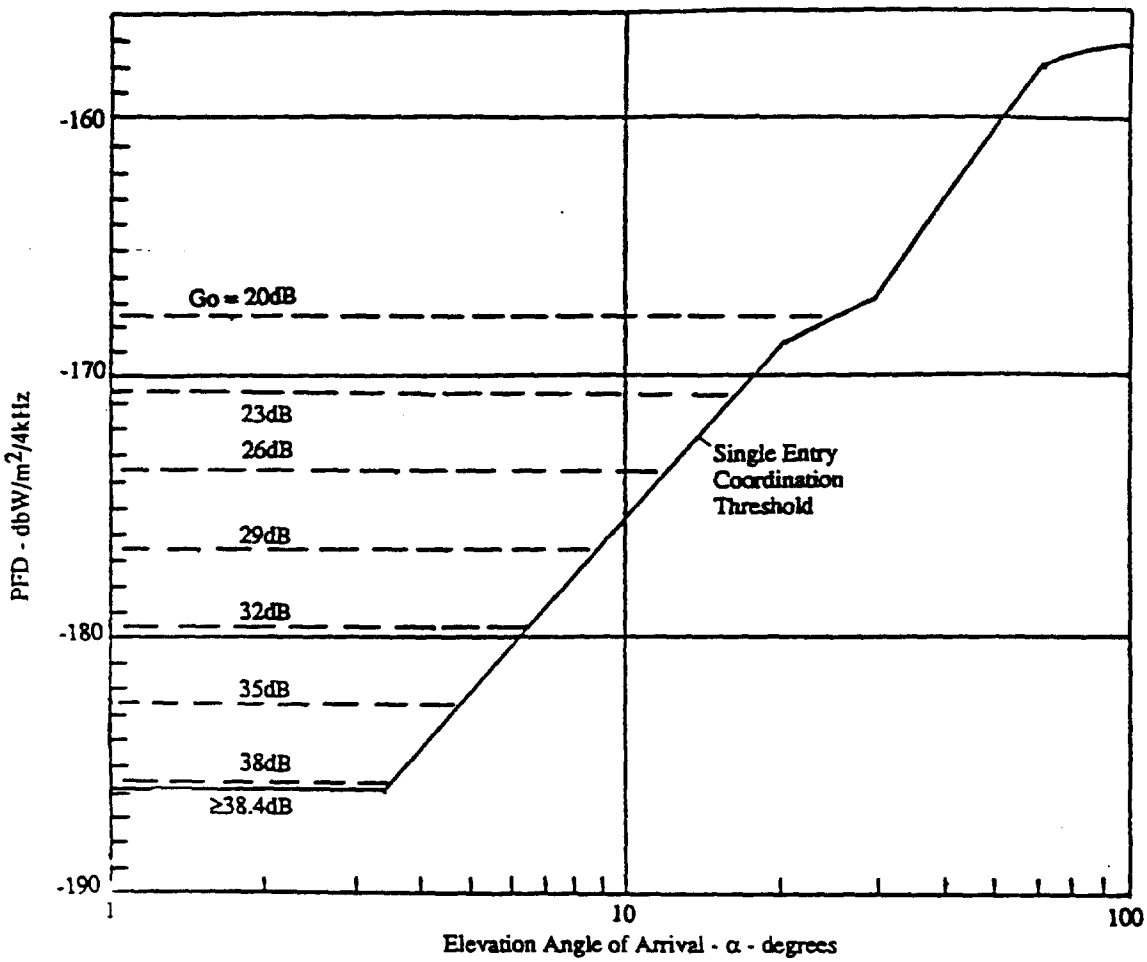


FIGURE 12

pfd versus (θ) - No conjunction geostationary case

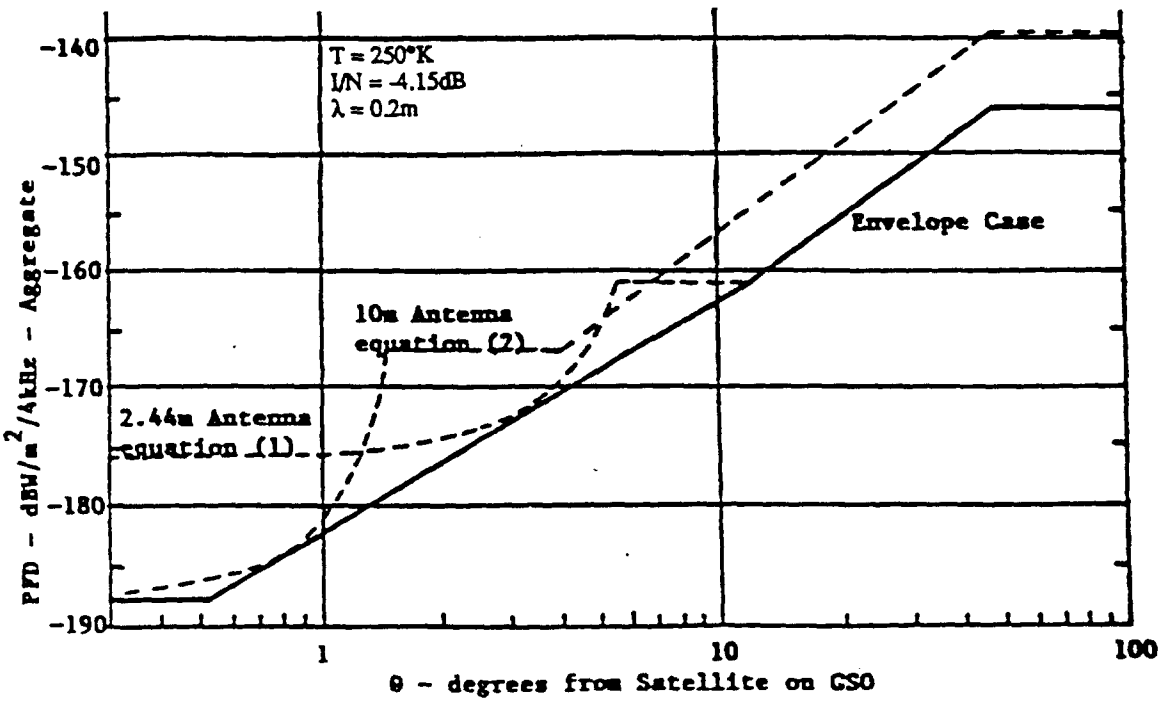
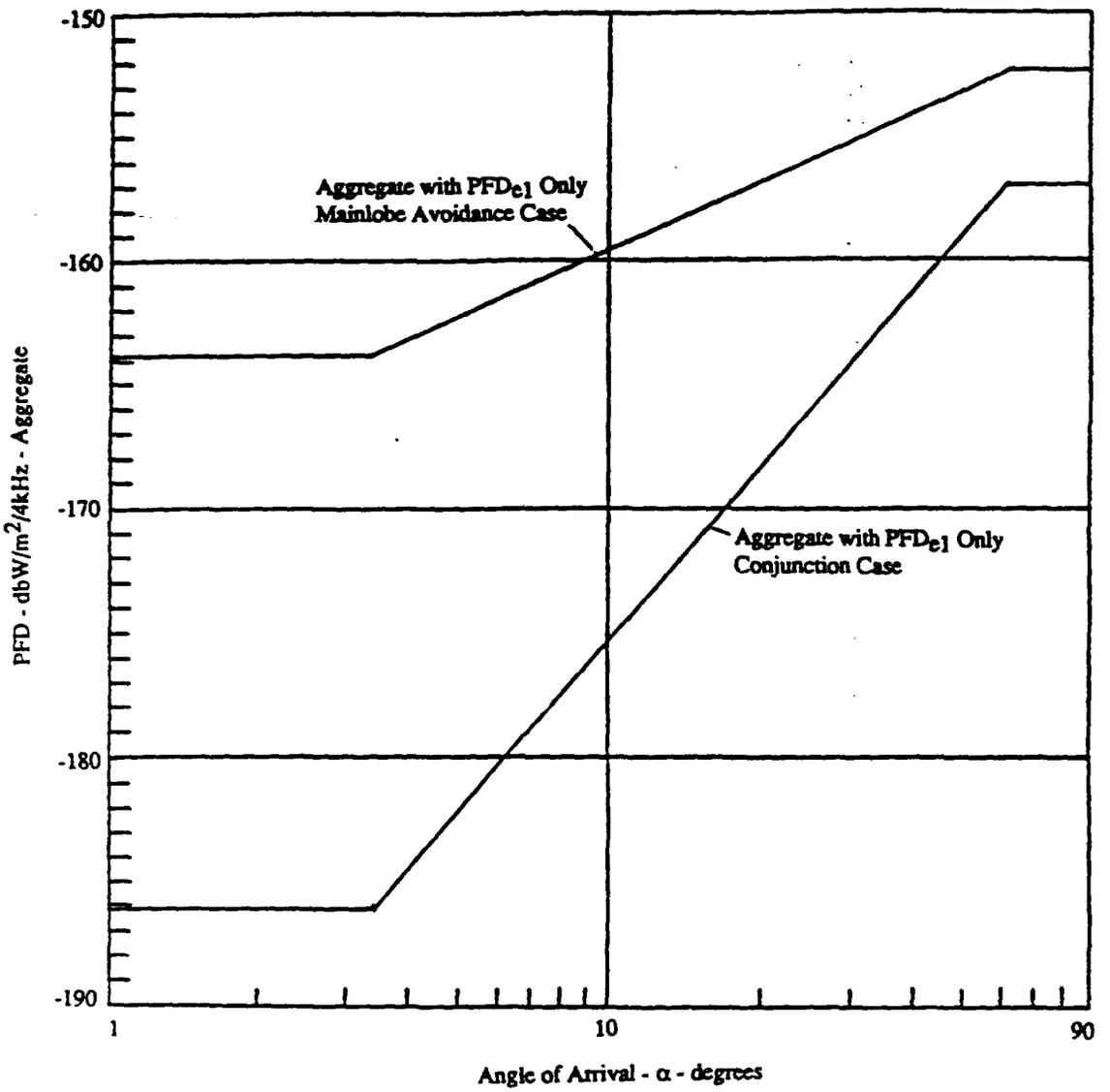


FIGURE 13

Main lobe avoidance versus conjunctions



APPENDIX 1

Aeronautical telemetry receiving station locations in the United States

Table A-1 shows the approximate location of telemetry receiving stations at many of the major test ranges. The list also contains the number of antennas and on-axis gains. For the large test ranges, some of the station locations may be ±1° from the indicated locations. Table A-2 shows a large portion of the additional telemetry receiving station locations. These stations have a small number of antennas (many have only one). The on-axis gains are between 20 dBi and 30 dBi. These locations are shown graphically in Fig. A-1.

In the case of isolated telemetry sites (no overlapping air space with any other site) with a relatively light testing schedule, it may be possible to avoid the use of portions of the 1 452 - 1 525 MHz band. In the usual case, where many overlaps occur and simultaneous testing occurs, frequency coordination between telemetry sites on a continuous basis is necessary and frequency avoidance will generally not be possible or practical.

Tables A-1 and A-2, though incomplete, indicate the extensive use of the 1 452 - 1 525 MHz band in the United States for mobile aeronautical telemetry operations. This use needs to be taken into account in the development of any sharing criteria with respect to the broadcasting satellite (sound), broadcasting (sound), and the mobile-satellite services.

TABLE A-1

Telemetry receiving stations on major test ranges

United States	COORDINATES		NUMBER AND GAIN OF ANTENNA							
State	Long.	Lat.	No.	dBi	No.	dBi	No.	dBi	dBi (max.)	No. total
Puerto Rico	66.7 W	18.3 N	1	28	7	30	1	34	34	9
New York	72.8 W	40.9 N	1	40					40	1
Virginia	76.0 W	36.9 N	2	30					30	2
Maryland	76.4 W	38.3 N	4	29	2	30	1	32	32	7
Florida	85.8 W	30.2 N	2	28					28	2
Florida	86.5 W	30.5 N	1	28	8	34			34	9
Missouri	90.4 W	38.8 N	1	22	1	29			29	2
New Mexico	106.4 W	33.2 N	7	28	1	36	2	38	38	10
Utah	113.2 W	41.0 N	1	21	2	28	1	34	34	4
Arizona	114.4 W	32.9 N	4	26					26	4
Nevada	116.8 W	37.8 N	5	28	1	33			33	6
California	117.5 W	35.8 N	3	25	6	26	2	30	30	11
California	117.9 W	34.9 N	10	28	1	33			33	11
California	119.1 W	34.1 N	1	27	2	37	4	40	40	7
California	119.5 W	33.2 N	4	28	2	37	3	39	39	9
California	120.4 W	34.6 N	1	28	1	39	1	41	41	3
California	122.5 W	37.5 N	2	41					41	2
Hawaii	159.7 W	22.0 N	3	28	3	39			39	6
	TOTAL:	18	TOTAL ANTENNAS:							105

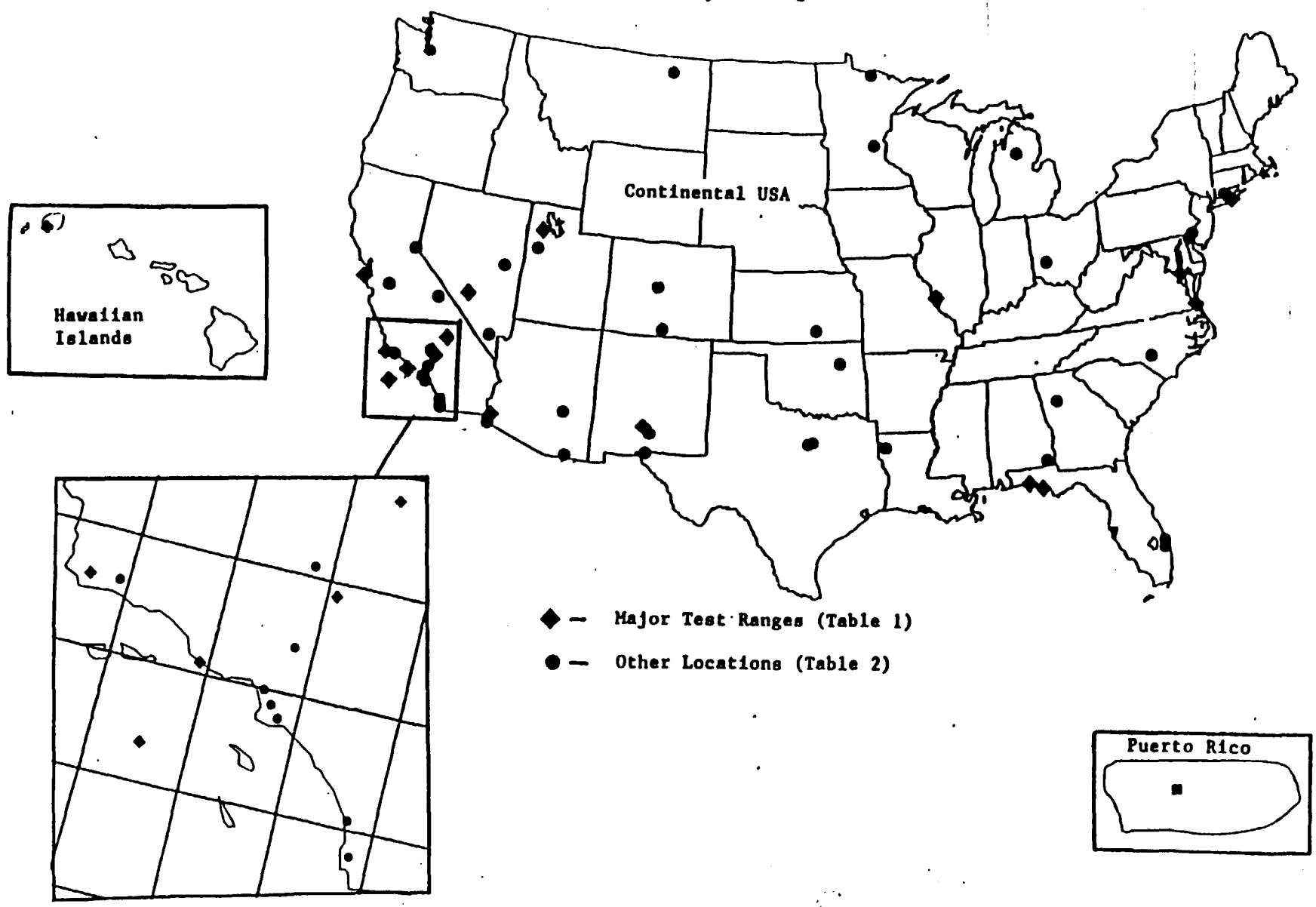
TABLE A-2

Additional telemetry receiving station locations

United States	COORDINATES		United States	COORDINATES		United States	COORDINATES	
State	Long.	Lat.	State	Long.	Lat.	State	Long.	Lat.
Connecticut	73.1 W	41.2 N	Kansas	97.3 W	37.6 N	California	117.2 W	32.8 N
Pennsylvania	75.3 W	39.9 N	Texas	97.5 W	32.8 N	California	117.3 W	33.1 N
Delaware	75.6 W	39.7 N	Texas	97.8 W	32.7 N	California	118.2 W	35.1 N
North Carolina	79.0 W	35.1 N	Colorado	105.9 W	37.4 N	California	118.2 W	34.4 N
Florida	80.2 W	27.2 N	New Mexico	106.1 W	32.9 N	California	118.2 W	33.8 N
Florida	80.3 W	26.9 N	Texas	106.2 W	32.1 N	California	118.3 W	33.9 N
Ohio	84.0 W	39.8 N	Colorado	106.3 W	39.2 N	California	118.4 W	34.0 N
Georgia	84.5 W	33.9 N	Montana	106.5 W	48.4 N	California	118.4 W	37.4 N
Michigan	84.9 W	44.6 N	Arizona	110.4 W	31.6 N	California	120.1 W	34.6 N
Alabama	85.5 W	31.4 N	Arizona	110.7 W	33.5 N	California	120.2 W	39.2 N
Minnesota	93.5 W	48.5 N	Utah	113.4 W	40.2 N	California	121.2 W	37.4 N
Minnesota	93.5 W	45.5 N	Arizona	114.6 W	32.5 N	Washington	122.3 W	47.5 N
Louisiana	93.7 W	32.5 N	Nevada	115.1 W	39.3 N			
Oklahoma	95.9 W	36.2 N	Nevada	115.3 W	36.2 N			

FIGURE 1

United States aeronautical telemetry receiving station locations



ATTACHMENT B

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

Document 8B/TEMP/30(Rev.1)-E
2 November 1993
Original: English only

Source: Doc. 8B/52

Working Party 8B

LIAISON STATEMENT TO TASK GROUP 12/4

With respect to the liaison statement from TG 12/4 to WP 8B (Docs. 8B/37 and 12-4/TEMP/23(Rev.1))*, WP 8B has examined the sharing situation between the aeronautical mobile (telemetry) service and the broadcasting-satellite service (sound). Extensive analyses have been performed to determine the protection required for the aeronautical mobile (telemetry) service in the band 1 452 - 1 492 MHz. The protection required is expressed as power-flux densities (pfds) at the Earth's surface. A comparison of this pfd with the one postulated for broadcasting satellite (sound) systems indicates that mutual sharing criteria which would avoid the need for coordination in all cases is not feasible. Therefore, coordination thresholds have been developed for the aeronautical mobile (telemetry) service for low-Earth orbit and geostationary satellites. A preliminary draft new Recommendation for coordination thresholds is attached. Annex 1 to this preliminary draft new Recommendation contains the analyses leading to the coordination thresholds.

With respect to Annex 1 of Doc. 12-4/TEMP/23(Rev.1), the following information is provided.

General information needed from other Working Parties

1. Technical and operational characteristics of reference systems to be protected

See § 2 of Annex 1 of Doc. 8B/TEMP/26(Rev.1).

2. Performance requirements

See § 2 of Annex 1 of Doc. 8B/TEMP/26(Rev.1). Required availabilities vary depending on the particular tests being performed. However, the statistical analyses presented in §§ 3 and 6 of Annex 1 of Doc. 8B/TEMP/26(Rev.1) show that the protection requirements are not very sensitive to availability requirements over a range of 95% to 99.95%.

* The content of Doc. 8B/37 is the same as in Doc. 12-4/TEMP/23(Rev.1).

3. Noise budget

See § 5 of Annex 1 of Doc. 8B/TEMP/26(Rev.1).

4. Protection requirements

See §§ 3, 4, 6 and 7 of Annex 1 of Doc. 8B/TEMP/26(Rev.1).

5. Limits on service from perspective of service provider

See § 8 of Annex 1 of Doc. 8B/TEMP/26(Rev.1) for coordination consideration.

A partial list of United States telemetry receiving station locations is also provided.

Attachment:

Doc. 8B/TEMP/26(Rev.1), "Coordination thresholds and techniques for the protection of mobile aeronautical telemetry systems in the band 1 452 - 1 525 MHz", preliminary draft new Recommendation.

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

Document 8B/TEMP/36(Rev.1)-E
2 November 1993
Original: English only

Source: Doc. 8B/TEMP/27

Working Party 8B

LIAISON STATEMENT TO WORKING PARTY 10-11S

Working Party 8B has examined the sharing situation between the aeronautical mobile (telemetry) service and the broadcasting-satellite service (sound). Extensive analyses have been performed to determine the protection required for the aeronautical mobile (telemetry) service in the band 1 452 - 1 492 MHz. The protection required is expressed as power-flux densities (pfds) at the Earth's surface. A comparison of this pfd with the one postulated for the broadcasting-satellite service (sound) indicates that mutual sharing criteria which would avoid the need for coordination in all cases is not feasible. Therefore, coordination thresholds have been developed for the aeronautical mobile (telemetry) service for low-Earth orbit and geostationary satellites. A preliminary draft new Recommendation for coordination thresholds is attached. Annex 1 to this preliminary draft new Recommendation contains the analyses leading to the coordination thresholds. The Annex also provides information on factors which may be considered in coordination.

A partial list of United States telemetry receiving station locations is also provided.

Attachment: Doc. 8B/TEMP/26(Rev.1), "Coordination thresholds and techniques for the protection of mobile aeronautical telemetry systems in the band 1 452 - 1 525 MHz", preliminary draft new Recommendation.

ATTACHMENT C

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION
STUDY GROUPS

Document 2-2/TEMP/4(Rev.1)-E
3 February 1994
Original: English only

Source: Docs. 2-2/4, 8B/TEMP/26(Rev.1), 8B/TEMP/30(Rev.1), 2-2/28, 2-2/30

Task Group 2-2

REPORT ON THE WORK OF SUB-WORKING GROUP 1-B

Sub-Working Group 1-B of Task Group 2/2 met beginning on 1 February 1994 for the purpose of determining the protection requirements of mobile aeronautical telemetry (MAT) systems and the potential for sharing with broadcasting-satellite service (sound) (BSS(S)) systems. Protection requirements for MAT are contained in Doc. 8B/TEMP/26(Rev.1) forwarded via a liaison statement Doc. 8B/TEMP/30(Rev.1) which are contained in Doc. 2-2/4. In particular, coordination threshold values (Type 2) of pfd are contained in **recommends** 1.2 of Doc. 8B/TEMP/26(Rev.1) with respect to BSS(S) systems in the 1 452 - 1 492 MHz band using geostationary satellites. These are the only values available at this time and are subject to further review and comments. The values are:

"For a geostationary satellite that will be visible to any aeronautical telemetry receiving station, the coordination threshold corresponds to a power-flux density at the telemetry receiving station in any 4-kHz band for all methods of modulation of:

-186.1	$dB(W/m^2)$ for $0 \leq \alpha \leq 3.4^\circ$
$-198.4 + 23.1 \log\alpha$	$dB(W/m^2)$ for $3.4^\circ < \alpha \leq 20^\circ$
$-182.0 + 10.5 \log\alpha$	$dB(W/m^2)$ for $20^\circ < \alpha \leq 30^\circ$
$-182.0 + 10.5 \log\alpha + 10 \log [1 + 0.066(\alpha-30)]$	$dB(W/m^2)$ for $30^\circ < \alpha \leq 62.5^\circ$
$-157.1 + 20 \log (\sin\alpha)$	$dB(W/m^2)$ for $62.5^\circ < \alpha \leq 90^\circ$

where α is the angle of arrival (degrees above the horizon)."

Doc. 8B/TEMP/26(Rev.1) also contains information concerning factors which may be used in coordination with the MAT system aspect. In particular, Figs. 11, 12 and 13 indicate the possible values in allowable pfd under certain conditions.

A comparison of the pfd values indicated for BSS(S) systems with the potential values of allowable pfd for MAT systems under favourable coordination conditions leads to the results given in Doc. 2-2/28. The results are:

1) co-frequency, co-coverage operation of BSS(S) and MAT systems in the 1 452 - 1 492 MHz band does not appear feasible;
2) co-frequency, non co-coverage operation of BSS(S) and MAT systems in the 1 452 - 1 492 MHz band will be very limited for geostationary BSS(S) satellites visible to MAT telemetry receiving stations.

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

Document 8D/218-E
2 November 1993
Original: English only

Received: 2 November 1993

Source: Docs. 8B/TEMP/27(Rev.1), 8B/54

Working Party 8B

LIAISON STATEMENT TO WORKING PARTY 8D

With respect to the liaison statement from Working Party 8D to Working Party 8B (Docs. 8B/31 and 8D/TEMP/76)* Working Party 8B has examined the sharing situation between the aeronautical mobile (telemetry) service and the mobile-satellite service. Extensive analyses have been performed to determine the protection required for the aeronautical mobile (telemetry) service in the band 1 492 - 1 525 MHz. The protection required is expressed as power-flux densities (pfds) at the earth's surface. A comparison of this pfd with the one postulated for mobile-satellite systems indicates that mutual sharing criteria which would avoid the need for coordination in all cases is not feasible. Therefore, coordination thresholds have been developed for the aeronautical mobile (telemetry) service for low-Earth orbit and geostationary satellites. A preliminary draft new Recommendation for coordination thresholds is attached. Annex 1 to this preliminary draft new Recommendation contains the analyses leading to the coordination thresholds. The Annex also provides information on factors which may be considered in coordination.

A partial list of United States telemetry receiving station locations is also provided.

Attachment: Doc. 8B/TEMP/26(Rev.1)**, "Coordination thresholds and techniques for the protection of mobile aeronautical telemetry systems in the band 1 452 - 1 525 MHz", preliminary draft new Recommendation.

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* The content of Doc. 8B/31 is the same as in Doc. 8D/TEMP/76.

** Note from the Secretariat: Doc. 8B/TEMP/26(Rev.1) is not attached to this document but will be distributed in the pigeon-hole.

INTERNATIONAL TELECOMMUNICATION UNION

RADIOCOMMUNICATION STUDY GROUPS

Document 8D/TEMP/119-E
3 November 1993
Original: English only

Working Party 8D

LIAISON STATEMENT TO WORKING PARTY 8B

Working Party 8D received a liaison statement from Working Party 8B (Doc. 8D/218) near the end of its meeting (27 October - 5 November 1993) and thus was not able to address the subject in detail at that meeting. The information contained in Doc. 8D/128 and the attached Doc. 8B/TEMP/26(Rev.1) is useful for studies relative to the sharing of the aeronautical mobile (telemetry) service and the mobile-satellite service in Region 2 in the frequency band 1 492 - 1 525 MHz.

It is noted, based on the information provided in Doc. 8B/TEMP/26(Rev.1), that a difficult sharing situation may exist between these two services in Region 2. It is requested that Working Party 8D be informed of the results of any additional studies by Working Party 8B. Working Party 8D will address the content of Doc. 8D/218 and its attachment at its next meeting.

ANNEX 1

Note for the use of TG 2/2.

No information is available as of this date on the aeronautical-mobile telemetry system in the 2 310 - 2 360 MHz band. However, the characteristics and protection criteria could be similar to those of systems operating in the 1 452 - 1 492 MHz band. There is a need to derive and incorporate in the preliminary draft new Recommendation coordination trigger levels for the 2 310 - 2 360 MHz band.

FRAMEWORK FOR A PRELIMINARY DRAFT NEW RECOMMENDATION

CRITERIA FOR COORDINATION AND SHARING BETWEEN THE BROADCASTING-SATELLITE SERVICE (SOUND) USING GEOSTATIONARY SATELLITES AND AERONAUTICAL-MOBILE TELEMETRY SYSTEMS IN THE BAND 1 452 - 1 492 MHz

(Resolution 528)

(Question 62/8)

The ITU-R,

considering

a) that in Region 2 and some Regions 1 and 3 countries the band 1 452 - 1 492 MHz is allocated to the aeronautical-mobile telemetry service on a primary basis by Nos. 723, 723B, 722C;

b) that at WARC-92 the band 1 452 - 1 492 MHz was allocated to the broadcasting-satellite service (sound), subject to the provision of Nos. 722A, 722B and 722C;

c) that the band 1 452 - 1 492 MHz is used in at least one Region 2 country (in excess of 145 telemetry receiving station) for the testing and certification of all aircraft manufactured therein with a very large investment in associated facilities;

d) that safety of life and property is a factor in endurance testing of aircraft;

e) that provisions for the introduction of the broadcasting-satellite service (sound) is also a factor;

f) that the aeronautical-mobile telemetry service requires interference protection from satellite transmitters in the broadcasting-satellite service (sound) using geostationary satellites;

g) that interference to an aeronautical telemetry receiving station can be caused from geostationary satellites over a large portion of the geostationary orbit;

h) that the broadcasting-satellite service (sound) also requires interference protection from airborne transmitters in the aeronautical-mobile telemetry service;

j) that there are no coordination trigger levels that apply with respect to protection of the aeronautical-mobile telemetry service or the broadcasting-satellite (sound) service;

k) that coordination is required under Resolution 528;

A missing element is the interference from airborne telemetry transmitters to BSS(S) receivers. However, the pfd versus distance and the associated probability can be developed from the information in Doc. 8B/TEMP/26(Rev.1) which in turn can be compared with the threshold pfd values of the BSS(S) receivers.

MAT systems also use the 2 310 - 2 360 MHz band which is allocated to the BSS(S) in the United States and India. It is noted in Doc. 2-2/30 that the analysis methods given in Doc. 8B/TEMP/26(Rev.1) can also be used in this frequency band.

A framework for a preliminary draft new Recommendation and a liaison statement to Working Party 8B were developed and are attached as Annex 1 and Annex 2 respectively.

ANNEX 2

LIAISON STATEMENT TO WORKING PARTY 8B

Task Group 2/2 (Sharing criteria between certain services in the range 1 - 3 GHz) met in Geneva from 31 January - 9 February 1994. One sharing situation addressed involved the broadcasting-satellite (sound) and the aeronautical-mobile telemetry service in the 1 452 - 1 492 MHz and 2 310 - 2 360 MHz bands. Information on aeronautical-mobile telemetry systems in both bands is needed.

The information provided in Docs. 8B/TEMP/26(Rev.1) and 8B/TEMP/30(Rev.1) is very comprehensive and useful with respect to the sharing of these two services in the 1 452 - 1 492 MHz band. TG 2/2 considers that the analysis methods given in Annex 1 of Doc. 8B/TEMP/26(Rev.1) appear to be reasonable for determining coordination trigger values and subsequent coordination possibilities from the standpoint of the aeronautical-mobile telemetry service.

It has been determined that low-Earth orbit (LEO) satellites are not currently envisioned to be used in the broadcasting-satellite (sound) service. Therefore, the immediate need for information relates to sharing with geostationary satellites. Sharing information is also needed with respect to broadcasting satellite (sound) systems using satellites in highly elliptical orbits (HEO's). Reference is made to Table 3 of Doc. [2-2/TEMP/18] and § 12 of Doc. 10/73 for further information.

TG 2/2 recognizes that co-frequency, co-coverage sharing of these services in the 1 452 - 1 492 MHz band may not be possible, However, WP 8B is requested to review the results given in Doc. 8B/TEMP/26(Rev.1) with the view of increasing the coordination trigger levels and increasing the feasibility of co-frequency, non-co-coverage sharing.

TG 2/2 currently has no information on aeronautical-mobile telemetry systems operating in the 2 310 - 2 360 MHz band. WP 8B is requested to provide the same information for this band with respect to geostationary satellites as contained in Doc. 8B/TEMP/26(Rev.1). In particular, it would be most appreciated if the administrations using this band for aeronautical-mobile telemetry systems would provide the type of information contained in Appendix 1 of Annex 1 of Doc. 8B/TEMP/26(Rev.1).

Additionally, information on aircraft emissions in both bands is needed to assess interference to broadcasting-satellite (sound) receivers. e.i.r.p. densities (dBW/4 kHz) along with their time-variability statistics would be most useful in determining separation distances.

Because WP 8B does not meet until after the next meeting of TG 2/2 (5-16 September 1994) it is requested that WP 8B take appropriate action to supply the information requested in a timely fashion. In particular, administrations ~~may be~~ urged to provide information directly to TG 2/2 in time for its next meeting~~, this information being subject to later review by WP 8B~~.

The following documents are attached for information and comment:

[Doc. 2-2/TEMP/4, Report of SWG 2-2/B;
Doc. 2-2/TEMP/18, BSS(S) characteristics];
Section 12 of Doc. 10/73